AMENDMENTS TO THE DRAWINGS

Please substitute the attached Replacement Sheet containing amended FIG. 24 for the corresponding drawing sheet of the original drawings. In the Replacement Sheet, FIG. 24 has been amended by re-labeling box 2412 to read, CHROMATICITY METER.

REMARKS

With the entry of this Amendment, claims 1, 3-10, 12-14 and 16-21will be pending in this patent application.

ENTRY OF AMENDMENTS

For reasons presented below, Applicant submits that the Amendments to the claims proposed herein overcome all of the objections and rejections lodged in the outstanding Office Action. Applicant therefore requests that these amendments be entered so that this application can be passed to issue. Alternatively, since the amendments to the claims place the claims in better condition for consideration on appeal, Applicant requests that these amendments be entered for purposes of appeal, if an appeal to the Board of Patent Appeals and Interferences should become necessary.

DRAWING AMENDMENT

Applicant is proposing an amendment to drawing FIG. 24, whereby the label in box 2412 would be changed from "CHROMATICITY" TO --CHROMATICITY METER--, for agreement with paragraph [0170] of the specification as filed. No new matter would be introduced by this amendment to the drawings.

OBJECTION TO CLAIMS

In this paper, Applicant is proposing to amend line 5 of claim 12, whereby "and/or" would read --or--, as suggested by the Examiner. A similar amendment is proposed to line 8 of claim 13.

In view of the foregoing proposed amendments, Applicant requests that the objection to the claims be withdrawn

PRIOR ART REJECTION I

Claim3 stands rejected under 35 USC § 102(b) as being anticipated by US 6411046 B1 (Muthu '046). Applicant traverses this rejection insofar as it might be deemed applicable to claim 3 with amendments proposed herein.

In this paper, Applicant is proposing amendments to claim 3 that would place this claim in condition for allowance. In particular, claim 3 would be amended to recite the subject matter of claim 22 and otherwise more particularly recite the functions performed by the light emitting element controller.

As explained below under the heading PRIOR ART REJECTION V, Muthu '046 does not offer a disclosure that could meet the clear requirements of amended claim 3.

In view of the foregoing observations, Applicant submits that the disclosure in Muthu could not properly serve as a basis for rejecting claim 3, as amended herein, under 35 USC § 102(b).

PRIOR ART REJECTION II

Claims 1, 4, 6-10, 12, 20 and 21 (***not*** claims 1, 4, 6-12, 20 and 21 as stated in the Office Action) stand rejected under 35 USC § 103(a) as being unpatentable over Muthu '046 in view of US 2002/0097000 A1 (Muthu '000). Applicant traverses this rejection insofar as it might be deemed applicable to claims 1, 4, 6-10, 12, 20 and 21 with amendments proposed herein.

Applicant is proposing to add the subject matter of claim 22 to independent claims 1, 4, 6, 9, 12, 20 and 21. The discussion below under the heading PRIOR ART REJECTION V, is applicable to this rejection.

On page 5 of the Office Action, the Examiner states, "[A]lthough MuthuPatent teaches the predetermined function of light output (lumens) to be a linear function of temperature variation (Muthu Patent, col. 2 lines 12-25, functions of col. 5 lines 16-22 and col. 4 lines 42-44 referring to first-order polynomials), MuthuPatent does not explicitly discloses the predetermined function based on drive current. However, MuthuPub2002 teaches that it is well known in the art that the light output (lumens) of the LED is proportional to the forward current (MuthuPub2002 para. 43 lines 14-16). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention, to use a proportional conversion of the MuthuPatent predetermined linear function (first order polynomial) of light output and heat-sink temperature (MuthuPatent col. 5 lines 17-23) and obtain a substantially linear formula of current and heat-sink temperature (given that lumen and forward current are proportional, thus they vary according to a constant multiple between them), because one of the ways to modify light output

is by modifying LED forward current, and thus, a formula of forward current as a linear function of heat-sink temperature would provide the benefit of enabling modification of the lumen output, as it is an objective of the MuthuPatent to obtain the required lumens for the LEDs (MuthuPatent, col. 5 lines 13-16)."

As explained below, linear function is not taught in the prior art but is instead a newly found relationship by the Applicants. It is true that "the light output (lumens) of the LED is proportional to the forward current," but what is claimed is (substantial) linearity of drive current and temperature, not output, at the condition that (1) the mixed light chromaticity is kept constant; (2) one (red) LED drive current is kept constant; and (3) other (green and blue) LED drive current is variable. See, for example, Figs. 11, 12, 13 and 14. The Examiner seems to have improperly conflated such specific conditions and relation of current and temperature, with known proportionality of LED input (current) and output (light intensity).

In fact, none of the applied references, including Muthu teach such specific conditions and the linear relationship. If these conditions and relationship had been known, then Muthu surely would have employed them instead of more complex quadratic function. Because Muthu did not know such a simpler relationship, he employed the special formula as disclosed.

The Examiner also concludes that it is obvious to "use a proportional conversion of the MuthuPatent predetermined linear function (first order polynomial) of light output and heat-sink temperature (MuthuPatent col. 5 lines 17-23) and obtain a substantially linear formula of current and heat-sink temperature..." The cited formulas in col. 5 lines 17-23 is not a linear expression, as explained below. Therefore, the examiner's observation of "first order polynomial" is incorrect.

Also, apparently the Examiner maintains that forward current would be substitutable or interchangeable in the vertical axis of CIE (color or lumen) in Fig. 5 of Muthu '046, given that the forward current and lumen is proportional. It is not known that proportionality of forward current and lumen can be established in the same rate even at the different temperature. This requies speculation at best. It could be a quadratic or cubic expression, and at least not obvious for the skilled person in the art.

Even if this hypotheses were true, still Fig. 5 of Muthu is different from the claimed invention, because all of three LED would show a linear function. Thus, in order to obtain a desired chromaticity, Muthu has to control all three LEDs. By contrast, claim 1 can maintain one (e.g., red) LED drive current as constant, i.e., need not variably control its current value. This is what the inventor newly found that it is onloy necessary to control another (green and blue) LED linearly. Such control is much easier, compared to Muthu technique in which all of three colors LED must be controlled.

The examiner also contends, "[A]lthough MuthuPatent teaches the predetermined function of light output (lumens) to be a linear function of temperature variation (Muthu Patent, col. 2 lines 12-25, functions of col. 5 lines 16-22 and col. 4 lines 42-44 referring to first-order polynomials),"

However, the cited portion of Muthu Patent adds, "A further aspect of the invention provides a method to vary the color temperature of the white light linearly. An example of this variance is shifting the color temperature from warm-white to daylight-white. This is achieved by expressing the CIE xy coordinates of the white light on the blackbody locus as a function of color temperature using polynomials." That is, Muthu '046 intentionally changes chromaticity, which is opposite to the claimed invention intending to *maintain* chromaticity.

On pages 10-11 of the Office Action, the Examiner states, "Regarding claim 9, MuthuPatent teaches LED lighting (MuthuPatent, luminaire of col. 1 lines 6-10) comprising: ... the LED controller drives one LED with any one of the chromaticities (MuthuPatent, Red, Green and BLUE LEDs col. 13 lines 18-22) at a constant current (When the forward current for the LED arrays is regulated by PWM, there is a constant peak current per col. 4 lines 26-36 of MuthuPatent)."

What is stated in Col. 4 lines 26-36 of Muthu '046 is, "The CIE xy chromaticity coordinates also vary with the forward current. The forward current for the LED arrays can be regulated, for example, by means of Amplitude Modulation (AM) or Pulse-width-modulation (PWM). If the amplitude modulation scheme is used, then CIE xy chromaticity coordinates with the temperature are measured for the average current for the operation. In the PWM scheme, the

effect of forward current on the CIE xy coordinates is eliminated due to the constant peak current. Here, the CIE xy coordinates with the temperature are measured at the peak current."

This passage in Muthu '046 refers to elimination of forward current effect on the CIE xy coordinates, which is totally irrelevant to the claimed invention. Applicant submits that Muthu '046 just discusses that CIE xy chromaticity coordinates changes depending on the instantaneous value or magnitude of forward current, thus the need to stabilize the current value or magnitude. This is why Muthu '046 says that Amplitude Modulation (AM) scheme can *measure* the CIE xy chromaticity coordinates with the temperature, *not eliminate* its effect. As is well known, PWM is basically series of rectangular wave, i.e., zero and high (the constant peak current), thus it creates or transforms more stabilized magnitude of current, compared with AM, thus the CIE xy coordinates are determined. In sum, this citation teaches that fine or minute control of current value to stabilize CIE xy coordinates, which does not relate to the claimed invention.

In view of the foregoing observations, Applicant submits that no reasonable combination of the disclosures in Muthu '046 and Muthu '000 could properly serve as a basis for rejecting claims 1, 4, 6-10, 12, 20 and 21, as amended herein, under 35 USC § 103(a).

PRIOR ART REJECTION III

Claim 5 stands under 35 USC § 103(a) as being unpatentable over Muthu '046 in view of Muthu '000 and further in view of US 2003/0011553 A1 (Ozaki). Applicant traverses this rejection insofar as it might be deemed applicable to claim 5 with amendments proposed herein.

With amendments proposed herein, claim 5 would incorporate the subject matter of claim 22. The discussion below under PRIOR ART REJECTION V, provides a rationale for the Applicant's contention that the requirements of claim 5, with amendments proposed herein, cannot be met or made obvious by any combination of the disclosures in Muthu '046, Muthu '000 and Ozaki.

In view of the foregoing observations, Applicant submits that no reasonable combination of the disclosures in Muthu '046, Muthu '000 and Ozaki could properly serve as a basis for rejecting claim 5, as amended herein, under 35 USC § 103(a).

PRIOR ART REJECTION IV

Claims 16-18 stand rejected under 35 USC § 103(a) as being unpatentable over Muthu '046 in view of Muthu '000 and further in view of US 2003/0016198 A1 (Nagai et al.). Applicant traverses this rejection insofar as it might be deemed applicable to claim 16-18 with amendments proposed herein.

With amendments proposed herein, these claims cannot be met or made obvious by any combination of the teachings in Muthu '046, Muthu '000 and Nagai et al., for reasons made evident in the discussion below under the heading PRIOR ART REJECTION V.

In view of the foregoing observations, Applicant submits that no reasonable combination of the disclosures in Muthu '046, Muthu '000 and Nagai et al. could properly serve as a basis for rejecting claims 16-18, as amended herein, under 35 USC § 103(a).

PRIOR ART REJECTION V

Claim 22 stands rejected under 35 USC § 103(a) as being unpatentable over Muthu '046 in view of Muthu '000 and further in view of US 2002/0175632 A1 (Takeguchi).

In this paper, Applicant is proposing that claim 22 be canceled. Applicant is also proposing that the subject matter of claim 22 be added to independent claims 1, 3-6, 9, 12-14, 16, 18, 20 and 21. Applicant is therefore addressing this rejection, because it would bear on the rejections applied to claims 1, 3-6, 9, 12-14, 16, 18, 20 and 21 and their dependent claims.

None of the applied references disclose or suggest:

(a) keeping one driving current constant, even if the temperature changes; and

(b) under condition (a), other chromaticity-current function can be represented as linear function, to maintain the chromaticity of the resultant mixed light.

Neither Muthu '046 nor Muthu '000 disclose such feature. Rather, they disclose adjusting all driving currents, based on quadratic function, to determine color coordinates, calculate the color coordinates and lumen output fractions on-line, which is quite different from the attributes recited in claim 22.

On page 27 of the Office Action, the examiner states, "MuthuPatent teaches the red, green and blue light outputs (and thus current) as a function of temperature variation and desired output of white light (MuthuPatent col. 5 lines 13-23). But, MuthuPatent in view of

MuthuPub2002 do not teach a white LED, and thus they don't teach the drive current of one LED with constant chromaticity for temperature variation while other LED's chromaticity is a linear function of temperature." (Emphasis added.)

The Examiner's inferential characterization of Applicant's disclosed and claimed light emitting apparatus is incorrect. In Applicant's light emitting apparatus, driving current, not chromaticity, is kept constant. Also, if the temperature changes, then the chromaticity also changes, even for the same driving current. Thus "constant chromaticity for temperature variation" is not achieved or employed in Applicant's disclosed and claimed invention.

Also, "a linear function of temperature" is not taught by Muthu. Rather, this concept is newly found by the Applicants. In particular, as for "linearity" disclosure, the Examiner cites, for example, on page 11, "Although MuthuPatent teaches the predetermined function of light output (lumens) to be a linear function of temperature variation (Muthu Patent, col. 2 lines 12-25, functions of col. 5 lines 16-22 and col. 4 lines 42-44 referring to first-order polynomials), MuthuPatent does not explicitly discloses the predetermined function based on drive current."

Col. 2 lines 12-25 of Muthu '046 states, "[A] further aspect of the invention provides a method to vary the color temperature of the white light linearly. An example of this variance is shifting the color temperature from warm-white to daylight-white. This is achieved by expressing the CIE xy coordinates of the white light on the blackbody locus as a function of color temperature using polynomials. ..." This statement, to "vary the color temperature of the white light linearly," is quite different from the object of Applicant's invention, which is to keep color chromaticity in temperature variation. As is well known, color temperature and LED temperature are completely different concepts.

Col. 5 lines 16-22 of Muthu '046 shows quadratic, not liner formulas. Although it appears as two lines of formulas ($L_R(T_H)$ and $L_G(T_H)$), actually the second line shows two formulas, i.e., before "$L_B(T_H)$=," a carriage return should be inserted. These formulas are correctly shown in Fig. 5 of Muthu '046, and they are clearly second order polynomial, quadratic expressions (although Fig. 5 looks almost like a linear function).

As for the citation of col. 4 lines 42-44, just before that citation, lines 37-41 read, "The variation in CIE x and CIE y coordinates with the heat-sink temperature for the Red, Green, and

Blue LED arrays are shown in FIGS. 2A, 2B, 3A, 3B, 4A, and 4B. The variation in CIE x and CIE y are non-linear and therefore, second order polynomials are used to express them." "The CIE x and CIE y coordinates for the Red and Blue LEDs can then be expressed by using first-order polynomials. Higher-order polynomials can also be used. Since the CIE y coordinate for the Green LED is non-linear, it is expressed by using a second-order polynomial."

In other words, the variation in CIE x and CIE y are non-linear and thus second order polynomials are used to express them. Although it says that the CIE x and CIE y coordinates for the Red and Blue LEDs can then be expressed by using first-order polynomials, no such example is evident. In fact, all figures show second order polynomials only. Even if the above statement is true, it only means "CIE x and CIE y coordinates for the Red and Blue LEDs can be expressed by using first-order polynomials," and it does not teach claimed feature of temperature-drive current function in linearity.

By contrast, as set forth in paragraph [0172] of Applicant's specification, and shown in Figs. 11, 12, 13 and 14, "... In this case, while the current that applied to the red LED 241 is held constant, only currents that are applied to green and blue LEDs 242 and 243 are adjusted. The currents that are applied to green and blue LEDs 242 and 243 exhibit values that are analogous to a linear function of the temperatures (see Figs. 11, 12, 13 and 14)." Such specific conditions (keeping one LED current constant and adjust others) and resulting linear function are simply not shown or suggested in Muthu. Applicant submits, then, that the Examiner has not established a *prima facie* case of obviousness, which is necessary to support a rejection based on 35 USC § 103(a).

Muthu's on-line calculation requires more hardware resources, while pre-measurement and pre-set of function, according to Applicant's teachings, does not require on-line calculation during normal operation, resulting in lower hardware requirement, as explained in the previous response.

Muthu "measures color coordinates for each LED light source for different temperatures," according to its abstract. Thus, Muthu measures each LED chromaticity respectively and independently at different temperature in order to obtain its function, thus it

would take longer time to complete all LED at different temperature, while the claimed invention measures the whole chromaticity of mixed light, which is much easier and requires less time.

Muthu just calculates the color coordinates and lumen output fractions, based on the input (desired) value of chromaticity. In other words, Muthu *does not* measure an actual chromaticity of the mixed light. Because Muthu operates based on ideal or target value, obtaining the practically adjusted chromaticity is uncertain, resulting in less reliability. This would significantly affect a semiconductor element such as an LED, that tends to suffer unevenness or variation in characteristics or properties.

In contrast, Applicant's disclosed and claimed invention actually measures the real chromaticity and presets the liner function accordingly, thus such unevenness or variation can be effectively removed, achieving higher reliability.

Stated somewhat differently, regardless of the particular chromaticity of particular LEDs, the claimed invention achieves the resulting chromaticity as a whole as desired in more flexible and practical manner.

The Examiner maintains (on page 35 of the Office Action), "[H]owever, Takeguchi teaches an LED lighting that has four LEDs, including red, green, blue and white LEDs (Takeguchi, para. 16). Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to use an additional white LED in MuthuPatent in view of Takeguchi's apparatus, to obtain the benefit of expressing neutral without lowering brightness (as taught by Takeguchi in para. 14). By doing so, the white LED's chromaticity will remain constant with temperature variation (because the white LED already produces white light), while the RGB LEDs will vary linearly (as explained for claim 21) according to temperature variation."

Applicant is mystified by the foregoing statement. If four LEDs are employed, i.e., red, green, blue and white LEDs, to emit white light, then it is sufficient to just turn off the red, green and blue, and turn on the white only, and thereby obtain single non-mixed white color with single chromaticity. Apparently it requires higher cost, larger space and power consumption. By contrast, Applicant obtains white (or other mixed) light by mixing two or more chromaticity LED, and this is why driving current(s) for green and blue LED are adjusted while keeping red

LED constant. The Examiner's observation is at odds with the fundamental object to obtain mixed light with constant chromaticity.

The foregoing discussion makes evident that there is no obvious combination of the disclosures in Muthu '046, Muthu '000 and Takeguchi that could meet the requirements of Applicant's claim 22.

In view of the foregoing observations, Applicant submits that no reasonable combination of the disclosures in Muthu '046, Muthu '000 and Takeguchi could properly serve as a basis for rejecting claim 22.

PRIOR ART REJECTION VI

Claims 14 and 19 stand rejected under 35 USC § 103(a) as being unpatentable over Muthu '046 in view of Muthu '000 and further in view of Nagai et al. and US 4604753 (Sawai).

With amendments proposed herein, these claims would incorporate the subject matter of claim 22. The requirements of these claims as amended could not be met or made obvious by the disclosures in Muthu '046, Muthu '000, Nagai et al. and Sawai, in any reasonable combination, for reasons made evident in the discussion above in PRIOR ART REJECTION V.

In view of the foregoing observations, Applicant submits that no reasonable combination of the disclosures in Muthu '046, Muthu '000, Nagai et al. and Sawai could properly serve as a basis for rejecting claims 14 and 19, as amended herein, under 35 USC § 103(a).

PRIOR ART REJECTION VII

Claim 13 stands rejected under 35 USC § 103(a) as being unpatentable over Muthu '046 in view of Muthu '000 and further in view of Ozaki and Takeguchi and the IEEE "White Light Emission" article authored by Sheu et al. (per the Examiner, "Sheu et al."). Applicant traverses this rejection insofar as it might be deemed applicable to claim 13 with amendments proposed herein.

With amendments proposed in this paper, claim 13 would include the subject matter recited in claim 22. The requirements of amended claim could not be met or made obvious by any reasonable combination of the disclosures in Muthu '046, Muthu '000, Ozaki, Takeguchi and

Sheu et al. Again, Applicant directs the Examiner's attention to the discussion in PRIOR ART REJECTION V, above.

In view of the foregoing observations, Applicant submits that no reasonable combination of the disclosures in Muthu '046, Muthu '000, Ozaki, Takeguchi and Sheu et al. could properly serve as a basis for rejecting claim 13, as amended herein, under 35 USC § 103(a).

CONCLUSION

In view of the amendments, observations and arguments presented herein, Applicant respectfully requests that the Examiner reconsider and withdraw the objections and rejections stated in the outstanding Office Action and recognize all of the pending claims as allowable.

If unresolved matters remain in this application, the Examiner is invited to contact Frederick R. Handren, Reg. No. 32,874, at the telephone number provided below, so that these matters can be addressed and resolved expeditiously.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.17; particularly, extension of time fees.

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Respectfully submitted,

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Attachments: Replacement Sheet (Fig. 24)